In the 35th Rep. of the New York State Botanist, p. 138, is reported the occurrence of *Protomyces marcrosporus* Ung. on leaves and stems of *Ambrosia trifida* L., at Albany, with a brief description that corresponds with the fungus on *Bidens*. Prof. Peck informs me that it was abundant at one station during one season. Through the kindness of Dr. Farlow I have had an opportunity to examine sections of a gall on *Ambrosia artemisiaefolia* L. which was sent him from Nantucket, Mass. in August 1905, containing spores similar to those in the *Bidens* galls.

Sydow described in *Annales Mycologici*, 1:237, *Entyloma leucanthemi* which was distributed by Vestergren (*Microm.* No. 808.) under the name *Protomycopsis leucanthemi* (Syd.) Magn. but I have been unable to learn of a publication of the characters of the genus. Again through the kindness of Dr. Farlow I have been able to examine sections containing this fungus. The spores are similar to those in *Bidens* but they appear to occur in the leaf blade without gall formation and no mention is made of such swellings by Sydow. I therefore hesitate to distribute my material under the name given by Magnus.

I have found the fungus here considered on no hosts other than *Bidens* — not even on *Corcopsis* growing with affected *Bidens* — and for my present purpose the question as to the relation between the *Ambrosia* and *Bidens* inhabiting forms may be left open.

I have made many attempts to observe the germination of the spores, at all seasons of the year, using material kept continuously out of doors but without result.

Racine, Wisconsin, August 6, 1907.

CULTURES OF UREDINEAE IN 1906.[1]

BY J. C. ARTHUR.

The present article forms the seventh of a series of reports[2] by the author upon the culture of plant rusts, covering the years from 1899 to the close of 1906. As in previous years the grass and sedge rusts have constituted a large part of the list of species under trial. This is partly due to the economic and scientific interest connected with them, but even more, possibly, to the greater ease with which wintered-over and viable spores may be secured for cultural study. Among the species whose life-

[1] Read before the Botanical Society of America at the New York meeting, December 31, 1906.

[2] See Bot. Gaz. *29*:268-276, *35*:10-23; Jour. Myc. *8*:51-56, *10*:8-21, *11*:50-67 and *12*:11-27.

cycle has now been worked out for the first time, the one having the greatest economic import does not belong to the grass or sedge forms, but inhabits flax. The discovery of the full developmental history of this serious menace to successful flax growing, brought about by the cooperation of Professor Henry L. Bolley of North Dakota, widely known for his interest and scientific studies in promoting the flax industry, has been a matter of much satisfaction. It greatly clarifies the problem of controlling the flax rust in the interest of the cultivator.

The work of testing the viability of spores, making the sowings, and recorded data, required, as in previous years, the undivided attention of a person to whom the whole work could be intrusted. The expense of such an assistant was this year met by a grant from the Botanical Society of America. It was the second time the Society has given material aid to this series of investigations.

Through the kindness of Professor R. A. Harper, I was so fortunate as to enlist the interest of Dr. E. W. Olive, lecturer at the University of Wisconsin, who consented to supervise the season's work. The forethought and constant watchfulness, the enthusiastic application, and especially the maturity of judgment and breadth of knowledge brought to bear on the work by Dr. Olive materially increased the completeness of the results.

As in former years correspondents have provided much of the material used in the trials, partly upon their own initiative, and partly in response to suggestion, for all of which I am under heavy obligation. Teliosporic material was sent by Messrs. A. D. Selby, Wooster, Ohio; H. H. Whetzel, Ithaca, N. Y.; Chas. E. Fairman, Lyndonville, N. Y.; W. A. Kellerman, Columbus, Ohio; H. L. Shantz, Columbia, Mo.; J. J. Davis, Racine, Wis.; John L. Sheldon, Morgantown, W. Va.; H. L. Bolley, Agricultural College, N. D.; E. Bartholomew, Stockton, Kans.; Geo. E. Morris, Waltham, Mass.; Guy W. Wilson, Lafayette, Ind.; E. Bethel, Denver, Colo.; and especially by Rev. J. M. Bates, Red Cloud, Neb. Aeciosporic material was sent by Messrs. Herman von Schrenk, St. Louis, Mo.; H. H. Whetzel, Ithaca, N. Y.; C. L. Shear, Tacoma Park, D. C.; D. Reddick, Ithaca, N. Y.; and P. H. Rolfs, Lake City, Fla., all the collections being either Caeoma or Peridermium on species of Pinus. Host plants are often required for the work, which do not grow in this vicinity, and can not be purchased from dealers, and for a number of such plants in good growing condition I am indebted to Messrs. William Trelease of the Missouri Botanical Garden, St. Louis, Mo.; John L. Sheldon, Morgantown, W. Va.; P. B. Kennedy, Reno, Nev.; and J. J. Davis, Racine, Wis.

During the present season 94 collections of material with resting spores and 15 collections with active spores were employed, from which 293 drop cultures and 6 Petri dish cultures

were made to test the germinating condition of the spores. Out of the 94 collections with resting spores 46 could not be made to germinate, although no reason could be assigned why they should not. This gave 48 collections of available material belonging to 30 species of rusts, exclusive of the aecial pine rusts, and from these 223 sowings were made. Beside these 53 sowings were made with Caeoma and Peridermium spores from pine, all without infection, 27 sowings with teliospores of Gymnosporangium, and 23 sowings with various aeciospores. Altogether 326 sowings were made, and for this purpose 134 species of hosts were required, which were grown temporarily in the greenhouse, where practically all the work was done. The results of this work are given in the following paragraphs, and are divided into negative results, positive results with species whose life histories have already been previously determined, and positive results with species whose life histories have not before been fully known.

Of the trials giving negative results the following may be recorded to serve for reference in further studies.

1. Puccinia on *Carex Pennsylvanica* Lam., collected near Lafayette, Ind., was sown on *Trillium recurvatum, Napaea dioica, Anemonella thalictroides, Isopyrum biternatum, Anemone virginiana, Actaea alba, Viola cucullata, Dirca palustris, Polemonium reptans, Ambrosia trifida, Rudbeckia laciniata,* and *Lactuca canadensis,* with no infection. Similar material in former seasons has been tried on eighteen other species of hosts with negative results.[3]

2. Puccinia on *Carex gravida* Bailey, sent by Rev. J. M. Bates from Red Cloud, Neb., was sown on *Actaea rubra, Thalictrum dioicum, Isopyrum biternatum, Apios Apios, Falcata comosa, Psoralea Onobrychis, Cassia Chamaecrista, Polygala Senega, Aesculus glabra, Ceanothus americanus, Smilax herbacea, Viola cucullata, Napaea dioica, Callirrhoe involucrata, Althaea rosea, Hibiscus Moscheutos, Macrocalyx Nyctelea, Polemonium reptans, Myosotis palustris, Phlox divaricata, Phlox subulata, Triosteum perfoliatum, Boltonia asteroides, Laciniaria pycnostachya, Rudbeckia laciniata, Senecio obovatus,* and *Cacalia reniformis,* with no infection. Similar material from the same source has been sown in previous years upon eleven other species of hosts with negative results.[4]

3. Puccinia on *Polygonum scandens* L., obtained in the vicinity of Lafayette, Ind., was sown five times on *Geranium maculatum,* twice on *G. Robertianum,* twice on *G. pusillum,* and

[3] See Jour. Myc. *10*:10. 1904; *11*:51. 1905; and *12*:12. 1906.
[4] See Jour. Myc. *10*:10. 1904; and *11*:52. 1905.

twice on *Thalictrum dioicum*. These sowings were made under seemingly favorable conditions and yet no infection resulted. In 1903 Dr. W. Tranzschel of St. Petersburg established the connection between *Puccinia Polygoni-amphibii* Pers. on *Polygonum amphibium* and the aecia on *Geranium palustre* and *G. pratense*, and a year later the writer corroborated the discovery with corresponding American species of hosts. In 1904 Dr. Tranzschel showed that the rust on climbing species of Polygonum, often included with the preceding, is distinct, either as a true species or a biological species, for it produces its aecia on *Geranium pusillum*. To see if this also could be substantiated with American material the above sowings were made with seemingly excellent teliosporic material, but the negative results leave the matter an open question. The only other native Geranium on which this form might be expected to grow readily is *G. carolinianum*, which was unfortunately not at hand for the test.

4. Puccinia on *Muhlenbergia diffusa* Schreb., sent by Rev. J. M. Bates from Red Cloud, Neb., was sown on *Trillium recurvatum, Actaea alba, Anemonella thalictroides, Isopyrum biternatum, Caulophyllum thalictroides, Apios Apios, Viola pubescens, Dirca palustris, Althaea rosea, Callirrhoe involucrata, Napaea dioica, Hibiscus Moscheutos, Marcrocalyx Nyctelea, Polemonium reptans, Ambrosia trifida*, and *Lactuca canadensis*, with no infection. This taken with previous trials shows that the rusts on different species of Muhlenbergia are in all probability biologically complex.

5. Puccinia Schedonnardi K. & S., sent by Rev. J. M. Bates from Red Cloud, Neb., was sown on *Callirrhoe involucrata, Althaea rosea*, and *Ceanothus americanus*, with no infection. Like material from the same source was sown in 1902 on eight other species of hosts with negative results.[5] The small sori and fine leaves of the grass make the manipulation of material of this species somewhat uncertain.

6. Puccinia emaculata Schw. on *Panicum capillare*, obtained in the vicinity of Lafayette, Ind., where it is very common, was sown on *Polygala Senega* and *Napaea dioica*. This rust was sown in previous seasons on eighteen other species of hosts.[6]

7. Uromyces on *Juncus effusus* L., sent by Dr. Charles E. Fairman from Ridgeway, N. Y., was sown on *Polemonium reptans, Houstonia purpurea, Ambrosia trifida, Rudbeckia laciniata, Polymnia canadensis, Parthenium integrifolium, Silphium integrifolium, S. perfoliatum S. terebinthinaceum*, and *Senecio obovatus*,

[5] See Bot. Gaz. *35*:11. 1903.

[6] See Bot. Gaz. *35*:12. 1903; Jour. Myc. *8*:52. 1902; *10*:10. 1904; and *12*:12. 1906.

with no infection. What was doubtless the same rust, and also from western New York, was sown in 1905 on two other species of hosts with negative results.[7]

This rust has heretofore been considered to belong to *Uromyces Junci* (Desm.) Tul., but recent study has shown that it is morphologically quite distinct from that species, especially as it has urediniospores that are echinulate and four-pored, instead of verrucose and two-pored, as in the European species, which by the way apparently does not occur in the United States east of Nebraska and Kansas. It was described by Schweinitz (Trans. Am. Phil. Soc. *4*:295. 1832.) as a new species under the name *Puccinia Junci*. As that specific name is not now available, I suggest that the species be called *Uromyces effusus*, in allusion to the copious distribution of the sori over the surface of the host, and would characterize it as follows:

Uromyces effusus sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, scattered, oblong or linear, 0.1-0.3 mm. wide by 0.3-1.5 mm. long, tardily naked, dark cinnamon-brown, ruptured epidermis very conspicuous; urediniospores broadly ellipsoid or oval, 14-19 by 18-26 μ, wall light yellow about 1.5μ thick, rather sparingly and bluntly echinulate, pores 4, equatorial.

III. Telia amphigenous, numerous, scattered, oblong or linear, 0.2-0.5 mm. wide by 0.3-2 mm. or more long, rarely confluent, finally naked, ruptured epidermis very conspicuous; teliospores obovate or broadly oval, 13-19 by 24-33 μ, obtuse or rarely acute at apex, usually narrowed below; wall chestnut-brown, 1.5-2 μ thick, much thicker above, 6-10 μ, smooth; pedicel tinted, about as long as the spore.

On *Juncus effusus* L. Type collected by L. von Schweinitz at Bethlehem, Pa. Collections in the writer's herbarium from Ohio, New York, West Virginia, and Maryland, and in the herbarium of the New York Botanical Garden from New Jersey, Massachusetts and South Carolina. It is also found in the following exsiccati: Ellis, N. Am. Fungi. 238; Ellis & Ev., Fungi Columb. 339; Ravenel, Fungi Am. 51; Shear, N. Y. Fungi 76; Kellerm., Ohio Fungi 38.

8. Uromyces Eleocharidis Arth. on *Eleocharis palustris* (L.) R. & S., sent by Mr. E. Bartholomew from Stockton, Kan., was sown on *Callirrhoe involucrata, Napaea dioica, Cassia Chamaecrista, Myosotis palustris*, and *Silphium perfoliatum*, with no infection.

9. Uromyces acuminatus Arth. on *Spartina cynosuroides* Willd., obtained at Fair Oaks, Ind. by Mr. F. D. Kern, was sown four times on *Steironema ciliatum*, twice on *S. lanceolatum*, twice on *Lysimachia quadrifolia* L., and once each on *L. terrestris, Polygala Senega, Napaea dioica* and *Houstonia purpurea*, with no infection. As teliosporic material of this rust, obtained from Nebraska, was sown on *Steironema ciliatum* with success in 1905,[8]

[7] See Jour. Myc. *12*:13. 1906.
[8] See Jour. Myc. *12*:24. 1906.

it would seem that what now passes under one name is either a segregate, or a series of biological species, and that the Uromyces on Spartina in Indiana differs in some way from that in Nebraska.

The following species of rusts were successfully grown, and the data supplement that obtained from previous cultures of this series, or that recorded by other American or European investigators.

1. Melampsora Bigelowii Thuem. — Teliosporic material obtained near Lafayette, Ind., on *Salix* sp., was sown April 25 on *Larix decidua,* pycnia appearing in abundance May 2, and fully grown aecia about May 12.[9]

2. Cronartium Quercus (Brond.) Schroet. — Work with this species was suggested by Dr. C. L. Shear, who also provided freshly gathered aecia on *Pinus virginiana* Mill., sending these a number of times in varying quantity. Dr. Shear made a number of cultures in the open in the spring of 1905, and presented a paper embodying his observations and conclusions[10] at the New Orleans meeting of the American Mycological Society, but which did not appear in print until June, 1906, after all data to be presented here were secured.

Aeciospores from material provided by Dr. Shear was sown May 12 in the greenhouse on three plants of *Quercus alba* and two plants of *Q. velutina.* On May 19 another sowing was made on two other plants of *Q. velutina.* This work coming late in the season did not receive daily examination, but on June 1 all the plants of *Q. velutina* showed uredinia, and one of them also had developed telia. By June 25 the remaining four plants had produced telia. The plants of *Q. alba* remained free from infection.

The aecia used for these cultures were the typical form of *Peridermium Cerebrum* Peck. There seems no reason to doubt the identity of the American, European and Japanese fungus, which has passed under a number of names, but a discussion of the literature and facts will not be taken up in this place.

3. Puccinia Opizii Bubák.— Aecia on various wild species of Lactuca, and even on the garden *L. sativa,* are common in the extended region of the upper Mississippi valley. They were described by Burrill (Bull. Ill. Lab. Nat. Hist. *2*: 232. 1885), but the name *Aecidium compositarum Lactucae* Burr. was first published three years later (Saccardo, Syll. fung. *7*: 799. 1888). This form has often appeared in considerable abundance within

[9] For previous cultures see Jour. Myc. *11*:60. 1905.
[10] Jour. Myc. *12*:89-92. 1906.

a hundred feet of my laboratory door, and much attention has been bestowed upon it. The first clue to its connection was found on the last day of April of this year, when in company with Mr. F. D. Kern, the writer detected at Fair Oaks, Ind., a hundred miles north of this place, in two well separated spots, some plants of *Lactuca canadensis* thickly covered with aecia, and intermixed with the affected leaves some leaves of a small, narrow leaved Carex, bearing teliospores of the previous year's growth. No evidence of fruiting could be found on the Carex, and roots brought back and grown in pots have shown no signs of fruit, so that the Carex has not been specifically determined. Teliosporic material was obtained from both localities, and May 2 one was sown on *Lactuca canadensis* and *Onagra biennis,* the other on *L. virosa* and two plants of *L. canadensis. Onagra* showed no infection, but all plants of Lactuca gave rise to pycnia May 9, and aecia May 15, in great abundance. Another sowing was made May 14 on *L. sativa,* which gave pycnia May 14, and aecia May 28, with ample development.

This rust is taken to be the same as the one which Dr. Fr. Bubák studied in Bohemia by means of cultures, and which he has very fully described.[11] No Bohemian collections, however, are at hand with which to make comparison, but two European collections of aecia (Sydow, Uredineen 334 and 1100) show essential morphological agreement with American aecia on Lactuca. Dr. Bubák (l. c.) has stated that to him the American and European collections appear distinct, but without saying wherein the difference may lie. To me the differences appear to be habitual. On thin leaved hosts both pycnia and aecia are in more open and indefinite groups. On hosts from the western prairies, which have firm and strongly developed leaves the groups of aecia are usually compact and circumscribed, and surround the often amphigenous pycnia. The European aecia belonging to the species are known under the name *Accidium lactucinum* Lagherh. & Lindr.

4. Puccinia Sambuci (Schw.) Arth. — Teliosporic material on *Carex Frankii* Kunth, brought from Frankfort, Ind., by Mr. F. D. Kern, was sown May 10 on *Sambucus canadensis,* giving numerous pycnia May 16, and abundance of aecia May 26. This adds another host to this common species, those already known being *Carex trichocarpa, C. lurida,* and *C. lupulina.*[12]

5. Puccinia Peckii (DeT.) Kellerm.— Teliosporic material on *Carex trichocarpa* Muhl., brought from Fair Oaks, Ind., was sown on *Onagra biennis* May 4, and gave rise to pycnia May 14, and to aecia May 17, both in abundance. Another collection on *C. lanuginosa* Michx., sent by Rev. J. M. Bates

[11] Centr. Bakt. 9^2:924. 1902.
[12] See Bot. Gaz. *35*:14. 1903; Jour. Myc. *8*:55. 1902; *12*:14. 1906.

from Wymore, Neb., was sown on Onagra biennis May 19, giving rise to pycnia May 26, and aecia June 2, both in abundance.[13]

6. Puccinia albiperidia Arth. — This rust on three species of hosts was obtained in different localities near Lafayette, Ind., and sown with the following results:

From *Carex squarrosa* L., sown in greenhouse April 16 on *Ribes rotundifolium;* April 21, pycnia; April 30, aecia.
From *C. squarrosa* L., sown in garden April 21 on *R. gracile;* April 25, pycnia; May 13, aecia.
From *C. squarrosa* L., sown in greenhouse April 16 on *R. rubrum;* no infection.
From *C. tetanica* Schk., sown in greenhouse April 20 on *R. Cynosbati;* April 27, pycnia; May 9, aecia.
From *C. crinita* Lam., sown on *R. Cynosbati* in greenhouse April 26, then plant transferred to garden; May 4, pycnia; May 17, aecia.

These results add one more telial host to those previously used for cultures.[14] They also have given an opportunity for a study of the differences between the pale aecia obtained by cultures and the highly colored aecia usually observed in the field. The aecia grown wholly in the greenhouse were pale, as in previous years; those on the plant which had the pot plunged into the garden soil after the fungus became established, were much more colored; and those raised from sowings made in the garden were highly colored and presented essentially the same appearance as others that came upon some nearby bushes of Ribes from natural infection. The result of observations during the last six years, coupled with the cultures of this year, make the conclusion almost inevitable that shade, moist air, and slow growth, tend to make the aecia smaller, with less coloring matter in the peridial cells and surrounding mycelium, and also tend to produce less hypertrophy of the tissues of the host, and that this accounts for the differences observed between aecia grown in cultures and those very common on *Ribes Cynosbati, R. rotundifolium, R. gracile,* and similar species of gooseberries throughout the eastern United States. All collections of this sort, therefore, may be called *Puccinia albiperidia,* but whether this is a distinct species from the very similar rust of Europe, *Puccinia Grossulariae* (Schum.) Lagerh., or one of the several biological species established by Klebahn, still remains an open question.

7. Puccinia angustata Peck. — Teliosporic material on *Scirpus atrovirens* Muhl., from the vicinity of Lafayette, Ind., was sown April 28, on *Dirca palustris,* with no infection. On

[13] For previous cultures see Bot. Gaz. *35*:13. 1903; Jour. Myc. *8*:55. 1902; *11*:58. 1905; and *12*:15. 1906.
[14] For previous cultures see Jour. Myc. *8*:53. 1902; *10*:11. 1904; *11*:58. 1905; and *12*:14. 1906.

May 4 it was sown on *Lycopus Americanus,* giving rise May 14 to numerous pycnia, and May 18 to aecia in abundance.[15]

8. Puccinia Eleocharidis Arth. — Teliosporic material on *Eleocharis palustris* (L.) R. & S., sent by Mr. E. Bartholomew from Stockton, Kans., was sown May 7 on *Eupatorium perfoliatum,* giving rise to pycnia May 14, and to aecia May 22. Similar material on same species of host from near Lafayette, Ind., was sown June 1 on *E. perfoliatum,* giving rise to pycnia June 8, and to aecia June 20. It was also sown on *Napaea dioica,* with no infection.[16]

9. Puccinia Andropogonis Schw. — Teliosporic material on *Andropogon scoparius* Michx., sent by Rev. J. M. Bates from Sargent, Neb., was sown April 24 on *Pentstemon hirsutus,* giving rise to pycnia April 30, and to aecia May 10, both in abundance.[17]

10. Puccinia tomipara Trel. — Teliosporic material on *Bromus purgans* L., from Lafayette, Ind., was sown May 19 on *Clematis virginiana,* giving rise to pycnia May 26, and to aecia June 8, both in abundance.[18]

11. Puccinia subnitens Diet. — Teliosporic material on *Distichlis spicata* (L.) Greene, sent by Rev. J. M. Bates from Red Cloud, Neb., was sown April 5 on *Chenopodium album, Bursa Bursa-pastoris,* and *Sarcobatus vermiculatus,* giving a weak infection only on the Chenopodium. As the Sarcobatus plant soon died, another sowing was made May 5 on two other plants of Sarcobatus, but with no infection. It was sown again May 10, and May 19, on Sarcobatus, still with no infection. Still a fifth sowing was made May 29 on two plants of Sarcobatus, and one of *Chenopodium album,* with a weak infection of the latter, and with apparently a few pycnia showing on one leaf of Sarcobatus. The plants of Sarcobatus were sent by Dr. P. B. Kennedy from Reno, Nev., and had not become established when the sowings were made. They were obtained where *Distichlis* spicata grew intermixed, well covered with *Puccinia subnitens,* and the Sarcobatus was well besprinkled with aecia, not distinguishable from those now known to belong to this grass rust.[19] The particular object in view was to determine experimentally if *Puccinia subnitens* will grow on *Sarcobatus.* The single seeming infection is doubtful, as it may have come from spores transported with the plants. The question remains an open one,

[15] For previous cultures see Bot. Gaz. *29*:273. 1900; and Jour. Myc. *8*:53. 1902.

[16] For previous cultures see Jour. Myc. *12*:23. 1906.

[17] For previous cultures see Bot. Gaz. *29*:272. 1900; Jour. Myc. *9*:10. 1903; and *10*:11. 1904.

[18] For previous cultures see Jour. Myc. *11*:62. 1905.

[19] For previous cultures see Bot. Gaz. *35*: 19. 1903; Jour. Myc. *11*:54. 1905; *12*:16. 1906.

although I venture the opinion that if the teliosporic material had come from Nevada, instead of Nebraska, the sowings would have been successful.

12. Puccinia poculiformis (Jacq.) Wettst. — Teliosporic material on *Agrostis alba* L., brought from Fair Oaks, Ind., was sown May 2 on two plants of *Berberis vulgaris,* both showing abundant pycnia May 9, and aecia May 18.

Aeciospores from these cultures were sown May 31 on *Avena sativa, Hordeum vulgare* (Great Beardless), and *Triticum vulgare* (Jones' Silver Sheaf), without infection in the first case, and with sparing infection in the other two cases, the former showing uredinia June 12, and the latter somewhat later.

Teliosporic material on *Elymus canadensis* L., sent from Racine, Wis., by Dr. J. J. Davis, was sown May 2 on *Berberis vulgaris,* showing pycnia May 9, and aecia May 18. Aecia from this culture were sown May 31 on *Triticum vulgare* (Jones' Silver Sheaf), and *Secale cereale* (Mammoth Winter Rye), with no infection.[20]

13. Puccinia transformans Ellis & Ev. — Teliosporic material from a greenhouse plant of *Stenolobium Stans,* which had been infected a year previously, was sown May 7 on two healthy plants of the same species, and gave rise to pycnia May 22, and to telia May 30. A sowing on two other plants was made May 10, showing pycnia May 26, and telia May 31.[21]

14. Puccinia Xanthii Schw.— Teliosporic material on *Xanthium* sp., obtained in the vicinity of Lafayette, Ind., about the middle of April, was sown on Xanthium seedlings April 20, and gave rise to translucent papillae simulating pycnia April 26, and open telia May 3. Another sowing May 1 gave pale papillae about May 18, and open telia about May 26.[22]

15. Puccinia Silphii Schw. — Teliosporic material on *Silphium integrifolium* Michx., obtained the last of March near Lafayette, Ind., was sown April 26 on *Silphium perfoliatum,* giving rise to pale papillae May 1, and open telia May 4. Another sowing was made on *S. terebinthinaceum* May 1, giving rise to pale papillae May 8, and open telia May 14. Similar material from another locality was sown May 3 on *S. integrifolium, S. perfoliatum* and *S. terebinthinaceum,* giving infection in usual way in each instance but exact data not taken.[23]. It was observed that the infection on *S. integrifolium* was more rapid in its growth and more abundant than on the other hosts. In the report of last

[20] For previous cultures see Jour. Myc. *8*:53. 1902; *11*:57. 1905; *12*:17. 1906.

[21] For previous cultures see Jour. Myc. *12*:22. 1906.

[22] For previous cultures see Jour. Myc. *12*:20. 1906.

[23] For previous cultures see Jour. Myc. *12*:21. 1906.

year's cultures the opinion was expressed that this rust may be composed of biological races, but the present work shows that adaptation to the hosts is not so close but that under specially favorable conditions the rust may be transferred from one host to another.

16. Puccinia Pruni-spinosae Pers.— Aecia on *Hepatica acutiloba* DC., from near Lafayette, Ind., were sown April 28 on *Prunus serotina* and *Amygdalus Persica,* giving rise May 21 to uredinia on the former host, but with no infection on the latter host. Like material was sown May 2 on *Prunus serotina* and *P. pumila,* giving rise to the uredinia in both instances May 21. These results abundantly confirm, and somewhat extend, the work of last year.[24]

17. Uromyces Scirpi (Cast.) Burr.— Teliosporic material on *Scirpus fluviatilis* (Torr.) A. Gray, sent by Rev. J. M. Bates from Walbach, Neb., was sown May 22 on *Cicuta maculata,* giving abundance of pycnia May 31, and of aecia June 8. A sowing made June 1 on *Pastinaca sativa,* the plants being especially thrifty, gave no infection. On June 5 another sowing was made on *Oxypolis rigidus* and *Cicuta maculata,* with no infection on the former, but with fine showing of pycnia on the latter June 12, and of aecia June 22.

There is apparently no morphological difference between the American rust and the corresponding European one, and the hosts are also much alike. Sixteen years ago Dr. P. Dietel showed by cultures[25] that in central Germany aecia are produced on *Sium latifolium,* which in habit and structure is much like *Cicuta maculata.* He also found that, most curiously, aecia could be grown from the same material on *Hippurus vulgaris,* which belongs to another family of plants, showing that, in all probability, the species is not closely circumscribed.

Cultures made by Dr. Fr. Bubák in 1901 from Bohemian material brought to light a biological form which only infected *Berula angustifolia.*[26]

In 1902 Dr. H. Klebahn attempted to repeat Dietel's cultures, and found that teliosporic material from the same immediate region, the exact locality having been changed and the rust destroyed, gave abundant aecia on *Pastinaca sativa,* but only slightly infected *Hippurus vulgaris,* and infected *Sium latifolium* and *Glaux martima* not at all.[27] The year following he carried out more extensive cultures. Teliosporic material raised from aeciospores on *Pastinaca sativa,* infected both *Pastinaca* and *Berula angustifolia.* Teliosporic material from central Germany

[24] See Jour. Myc. *12*:19. 1906.
[25] Hedwigia *29*:149. 1890.
[26] Centr. Bakt. *9*²:926. 1902.
[27] Jahrb. Hamb. Wiss. Anst. *20*:33. 1903.

infected both these hosts. Similar material from northern Germany infected only Berula. In 1904 aecia were raised in a similar way on *Oenanthe aquatica.*[28]

One of the earliest cultures with this pleophagic species was made by Mr. C. B. Plowright with English material, raising aecia on *Glaux maritima,* which belongs to the *Primulaceae.*[29]

A careful microscopic study of all these forms shows close agreement in morphological characters, and altogether there appears to be no reason to treat these cultural forms other than biological races of a single species. *Scirpus fluviatilis* is the American representative of the European *S. maritimus,* and by many authors is given the latter name. The writer has examined American collections that appear to belong to this species, as follows: on *S. fluviatilis* from Iowa, Illinois, Kansas, Nebraska, South Dakota, Ohio, and Wisconsin; on *Cicuta maculata* from Illinois, Iowa, and Colorado; on *Oenanthe californica* from central California, *Sium cicutaefolium* from Wisconsin, and on *Glaux maritima* from Montana and Wyoming.

18. Gymnosporangium Juniperi-virginianae Schw.— Galls from a tree of *Juniperus virginiana* near the laboratory, brought in by Mr. F. D. Kern, were used for sowing May 1 on *Malus coronaria, Sorbus americana,* and *Crataegus Pringlei.* Only the first gave infection, which showed abundant pycnia on May 14, but failed to develop aecia on account of injuries.[25]

19. Gymnosporangium globosum Farl.— Galls from a tree of *Juniperus virginiana,* found in the vicinity of Lafayette, Ind., were brought in by Mr. Guy W. Wilson, and used for making three sowings on *Crataegus Pringlei,* and one each on *Malus coronaria* and *Amelanchier* sp. All sowings on Crataegus gave abundance of pycnia, and one plant finally produced well formed aecia, the other plants not growing well. No infection was obtained on the other two hosts.

Similar material was also received from Dr. John A. Sheldon, of Morgantown, W. Va., and sown May 19 on *Crataegus Pringlei, Malus coronaria,* and *Sorbus americana,* all giving rise to an abundance of pycnia. As none of the plants grew well, only the sowing on Sorbus formed aecia, these finally reaching maturity and showing the characteristic structure of the species.

These results are parallel with, and confirm the work by Dr. Roland Thaxter, done some years ago.[26]

---

[28] Ztschr. Pfl.-Kr. *15*:74. 1905.
[29] Gard. Chron. III. *7*:682. 1890.
[25] For previous cultures see Jour. Myc. *12*:13. 1906.
[26] Proc. Amer. Acad. Sci. *22*:263. 1887; Bot. Gaz. *14*:167. 1889.

The following three species have never before been tested by means of cultures, so far as the writer knows. Although few in number, they make an important addition to our knowledge of life histories:

1. Melampsora Lini (Link) Desmaz.— For a number of years attempts have been made to obtain cultures of this cosmopolitan rust, and learn its full cycle of development. Many collections from different parts of the country, gathered at different times from November to April, have been tested, but with uniform failure to secure germination of the teliospores. The most numerous and promising collections were sent by Professor H. L. Bolley, of North Dakota, but equally in vain until one made the last day of April on cultivated flax, dug from under a snow bank, was received. This showed strong germination of the teliospores, and on May 4 was sown on *Linum Lewisii, Larix laricina,* and the day following on *Tsuga canadensis,* and *Arisaema triphyllum.* No clues were available, but judging from the willow, poplar, and some other species of the same genus, it was assumed that it might be heteroecious. Nevertheless, on May 16 pycnia began to appear on the flax, and on May 21 aecia. The next sowing was made May 18 on *Linum usitatissimum,* plants of which had not before been available, giving rise to pycnia May 26, and aecia May 30. Another equally successful sowing on the same host was made May 29, but exact record for the appearance of the sori was not kept.

The pycnia are small, pale, and inconspicuous, although numerous. They are globoid, subepidermal, and without ostiolar filaments. The aecia are of the caeoma form, that is, are without peridia. They are also rather pale, and not as prominent as the uredinia, for which, however, they might easily be mistaken. So far as I can learn they have never been collected, although probably common throughout the world. This may be due to their being inconspicuous, and quite as much to the earliness of their appearance.

The economic bearing of the discovery is to some extent obvious. Knowing the autoecious nature of the rust makes the destruction of old flax straw in flax growing regions a matter of moment, in order to lessen and retard the appearance of the rust in growing fields of flax. Upon reporting the first success to Professor Bolley he replied under date of May 23, 1906: "I am very much pleased to receive your letter, for with the information I am able to determine the source of a rust epidemic that we had in our flax breeding plots last year. I now find everywhere in the flax stubble plenty of volunteer flax with almost every plant more or less infected with spermogonia and aecidia." It will now be possible to intelligently devise methods for the practical control of flax rust.

2. Uromyces on Juncus tenuis.— This rust, which has generally passed under the name of *Uromyces Junci,* is very common in the United States east of the Rocky Mountains from Canada to the Gulf of Mexico. It is often highly parasitized, so that the sori contain few or no well grown teliospores. A number of attempts to bring the rust under culture have failed because the teliospores could not be made to germinate. In 1902 a sowing was made on *Iris virsicolor* without success.

Unparasitized material on *Juncus tenuis* Willd. was found near Lafayette, Ind., April 3, that proved to be viable, and was sown April 20 on *Lactuca canadensis, L. virosa, Senecio obovatus, Rudbeckia laciniata, Ambrosia trifida, A. artemisiaefolia,* and *Silphium perfoliatum.* Much to our delight pycnia were observed on the last host April 30, and were followed by a great abundance of aecia May 7. Another sowing was made May 4 on *S. perfoliatum* and *S. terebinthinaceum,* and the next day on *Parthenium integrifolium.* Only the first was infected, showing pycnia May 17, and May 31. The plant of *S. terebinthinaceum* was weak and did not grow well. Later sowings May 9 on *Polymnia canadensis,* and June 5 on *Pathenium integrifolium* and *Silphium terebinthinaceum,* gave no infection.

Another collection of teliospores on *Juncus tenuis* was sent by Dr. John L. Sheldon from Morgantown, W. Va., which was found close to *Houstonia caerulea* bearing aecia. This material was sown May 19 on *Houstonia caerulea, H. purpurea* and *Silphium perfoliatum.* No infection occurred on the Houstonias, but pycnia appeared on the *Silphium* May 29, and aecia June 4, both abundant and well formed.

Since obtaining the unequivocal cultural results, a morphological study has been made of the rust, which clearly demonstrates that it is specifically distinct from *Uromyces Junci* (Desm.) Tul. As it appears never to have been recognized as an autonomous species, the following name and description are submitted:

Uromyces Silphii (Syd.) nom. nov. (*Accidium compositarium Silphii* Burr. Saccardo, Syll. Fung. 7:798. 1888; *Accidium Silphii* Sydow, Uredineen *1546.*)

O. Pycnia chiefly epiphyllous, in small groups, golden brown, subglobose or ellipsoid, subepidermal, 80-100 μ broad by 80–110 μ high; ostiolar filaments up to 65 μ long.

I. Aecia amphigenous, in groups 4-10 mm. across, crowded about the pycnia on discolored spots, deep-seated, short, 0.2-0.4 mm. in diameter; peridium colorless, margin recurved, lacerate, peridial cells rhombic, 20-28 μ across, outer wall thick, 6-8 μ, transversely striate, inner wall thinner, 4-6 μ, moderately verrucose; aeciospores angularly globoid, small, 13-18 μ in diameter, wall colorless, thin, about 1 μ, minutely verrucose.

On *Silphium integrifolium* Michx., Illinois (type, McLean County, May 3, 1881 or 1882, *A. B. Seymour 4852,* recorded in Burrill's Parasitic Fungi of Illinois, page 231), Wisconsin; *S. terebinthinaceum* Jacq., Illi-

nois, Wisconsin, Missouri; *S. perfoliatum* L., Indiana, Iowa, Wisconsin; *S. laciniatum* L., Illinois, Iowa, Kansas.

II. Uredinia amphigenous, scattered, roundish or somewhat elongated, small, 0.2-0.3 mm. wide, by 0.3-0.5 mm. long, tardily naked, dark cinnamon-brown, ruptured epidermis not conspicuous; urediniospores broadly ellipsoid or sometimes obovate, 13-19 by 15-23 μ, wall golden yellow, about 1.5 μ thick, sparsely and bluntly echinulate, pores 5 or 6, scattered.

III. Telia amphigenous, scattered, roundish or somewhat elongated, small, 0.2-0.3 mm. wide by 0.2-0.6 mm. long, tardily naked, firm, somewhat pulvinate, blackish brown, ruptured epidermis noticeable; teliospores angularly obovate, rounded, truncate or occasionally pointed above, usually narrowed below, 12-19 by 26-35 μ, wall chestnut-brown, 1.5-2 μ thick, much thicker above, 7-10 μ, smooth; pedicel light chestnut-brown, one to one and a half times length of spore.

On *Juncus tenuis* Willd., Indiana, Iowa, Wisconsin, Michigan, Minnesota, South Dakota, Missouri, New York, Maine, Massachusetts, West Virginia, Louisiana, Texas; *J. dichotomus* Ell., Florida.

It has been issued in the following exsiccati: aecial stage — Ellis & Ev. Fungi Columb. 1478; Sydow, Ured. 1546; telial stage — Seym. & Earle, Econ. Fungi 52, 528; Griffiths, W. Am. Fungi 244 (host *J. tenuis* not *J. longistylis*); Ellis & Ev. Fungi. Columb. 2394.

The following key will serve to separate the three common species of Uromyces on Juncus, when the urediniospores are present. In the absence of uredinia the urediniospores can usually be found to some extent in telial sori, even those that have withstood the winter, and are collected in the spring following their maturity, and especially so if they are parasitized.

Urediniospores verrucose, pores 2, equatorial.....*U. Junci* (Desm.) Tul.
Urediniospores echinulate, pores 4, equatorial.....*U. effusus* Arth.
Urediniospores echinulate, pores 5-6, scattered....*U. Silphii* (Syd.) Arth.

3. Gymnosporangium Nelsoni Arth. — At the time this species was published it was stated that Prof. Aven Nelson, the collector of the type material, considered it highly probable that the aecia found on Amelanchier in the vicinity belonged to the species. Teliosporic material on *Juniperus scopulorum* Sarg., sent by Mr. E. Bethel from Colorado this spring, gave the first opportunity to test the suggestion. Sowings were made May 29 on the leaves of *Amelanchier canadensis, Sorbus americana, Crataegus Pringlei, Pyrus japonica,* and *Aronia nigra.* On June 12 a few pycnia were observed on the Amelanchier and Sorbus, but owing doubtless to indifferent growth of the hosts no aecia were formed. The other hosts remained without infection. This helps in a small way to confirm Professor Nelson's suggestion, but is not conclusive.

SUMMARY.

The following is a complete list of successful cultures made during the season of 1906. It is divided into two series: species previously reported by the writer or other investigators, and species now reported for the first time.

A. Species previously reported.

1. Melampsora Bigelowii Thuem. — Teliospores on *Salix* sp. sown on *Larix decidua* Mill.

2. Cronartium Quercus (Brond.) Schroet.— Aeciospores on *Pinus virginiana* Mill. sown on *Quercus velutina* Lam.

3. Puccinia Opizii Bubák.— Teliospores on *Carex* sp. sown on *Lactuca canadensis* L., *L. virosa* L. and *L. sativa* L.

4. Puccinia Sambuci (Schw.) Arth. — Teliospores on *Carex Frankii* Kunth sown on *Sambucus canadensis* L.

5. Puccinia Peckii (DeT.) Kellerm. — Teliospores on *Carex trichocarpa* Muhl., and also on *C. lanuginosa* Michx., sown on *Onagra biennis* (L.) Scop.

6. Puccinia albiperidia Arth. — Teliospores on *Carex squarrosa* L., *C. tetanica* Schk., and *C. crinita* Lam. sown on *Ribes rotundifolium* Michx., *R. gracile* Michx. and *R. Cynosbati* L.

7. Puccinia angustata Peck. — Teliospores on *Scirpus atrovirens* Muhl. sown on *Lycopus americanus* Muhl.

8. Puccinia Eleocharidis Arth. — Teliospores on *Eleocharis palustris* (L.) R. & S. sown on *Eupatorium perfoliatum* L.

9. Puccinia Andropogonis Schw. — Teliospores on *Andropogon scoparius* Michx. sown on *Pentstemon hirsutus* (L.) Willd.

10. Puccinia tomipara Trel. — Teliospores on *Bromus purgans* L. sown on *Clematis virginiana* L.

11. Puccinia subnitens Diet. — Teliospores on *Distichlis spicata* (L.) Greene sown on *Chenopodium album* L.

12. Puccinia poculiformis (Jacq.) Wettst. — Teliospores on *Agrostis alba* L. and on *Elymus canadensis* L. sown on *Berberis vulgaris* L., and aeciospores from *B. vulgaris* L. sown on *Hordeum vulgare* L. and *Triticum vulgare* Vill.

13. Puccinia transformans Ellis & Ev. — Teliospores on *Stenolobium Stans* (L.) Don sown on same host.

14. Puccinia Xanthii Schw. — Teliospores on *Xanthium* sp. sown on same host.

15. Puccinia Silphii Schw. — Teliospores on *Silphium integrifolium* Michx. sown on *S. integrifolium* Michx., *S. perfoliatum* L., and *S. terebinthinaceum* Jacq.

16. Puccinia Pruni-spinosae Pers. — Aeciospores on *Hepatica acutiloba* DC. sown on *Prunus serotina* Ehrh. and *P. pumila* L.

17. Uromyces Scirpi (Cast.) Burr. — Teliospores on *Scirpus fluviatilis* (Torr.) A. Gray sown on *Cicuta maculata* L.

18. Gymnosporangium Juniperi-virginianae Schw. — Teliospores on *Juniperus virginiana* L. sown on *Malus coronaria* (L.) Mill.

19. Gymnosporangium globosum Farl. — Teliospores on *Juniperus virginiana* L. sown on *Crataegus Pringlei* Sarg., *Sorbus americana* Marsh., and *Malus coronaria* (L.) Mill.

B. Species reported now for the first time.

1. Melampsora Lini (Link) Desmaz. — Teliospores on *Linum usitatissimum* L. sown on *L. Lewisii* Pursh and *L. usitatissimum* L.

2. Uromyces Silphii (Syd.) Arth.—Teliospores on *Juncus tenuis* Willd. sown on *Silphium perfoliatum* L.

3. Gymnosporangium Nelsoni Arth. — Teliospores on *Juniperus scopulorum* Sarg. sown on *Amelanchier canadensis* (L.) Medic. and *Sorbus americana* Marsh.

AN HISTORICAL REVIEW OF THE PROPOSED GENERA OF PHYCOMYCETES.

I. PERONOSPORALES.

GUY WEST WILSON.

In the present consideration of the generic types of the *Phycomycetes* the genera will be arranged chronologically under each order, with the type species, the synonyms, the homonyms, and such other information under each genus as may seem desirable. This is followed by an alphabetical list of the genera with their type species, in which the tenable names are printed in black type while those which are untenable are in common type.

The subject of the generic types of the *Phycomycetes* was first taken up at the suggestion of Dr. J. C. Arthur, while a student in his laboratory, and the results embodied in a thesis which was presented to the Faculty of Purdue University, to the authorities of which institution I am indebted for permission to publish the material contained in the thesis. I wish to also express my hearty appreciation of the courtesies shown me by Dr. Arthur and by Dr. J. H. Barnhart in the way of critical and bibliographical assistance and the loan of otherwise inaccessable books and by those in charge of the various libraries consulted both in Lafayette and New York.